

Institution: London South Bank University
Unit of Assessment: 24 - Sport and Exercise Sciences, Leisure and Tourism
<p>1. Unit context and structure, research and impact strategy</p> <p>a. Unit Context</p> <p>This submission presents the research activities of the Sport and Exercise Science Research Centre (SESRC) established at London South Bank University (LSBU) in 1994. SESRC's long-term strategic vision is to conduct and promote research in Sport and Exercise related Sciences that is scientifically excellent, innovative and rigorous, as well as relevant and impactful on our communities and stakeholders. In the pursuit of achieving this vision, SESRC undertakes activities that address major scientific priorities and societal challenges related to sport performance, physical activity and health, sport and exercise behaviours and related technological innovations.</p> <p>Led by 5-year research and impact strategies, aligned to LSBU <i>Corporate Plans</i> and supported by steadily increasing income and capacity, SESRC has built a thriving research environment and achieved sustained international recognition as a hub for excellent and impactful fundamental research in Sports and Exercise Sciences. SESRC research quality, volume and intensity achieved consistently high and increased rankings in the Research Assessment Exercises from 1996 onwards (RAE1996; RAE2001; RAE2008). Moreover, in REF2014 SESRC submitted 100% eligible staff and received a 75% internationally excellent (3*) rating for its <i>Research Environment</i> and 90% for <i>Impact</i>, with 67% of <i>outputs</i> rated at world leading (4*/3*) level. In the REF2021 cycle, our strategic investment in research expertise, doctoral scholarships, high-profile collaborations and infrastructure stimulated substantial increase in the volume, quality and outreach of our research activities that exceeded our targets set in 2014. The team has grown by 13% and attracted 50% more income from research grants compared to REF2014. In collaboration with 90 partner universities we published 155 research outputs (14 outputs/FTE), 36% of which rank within the top 25% Field-Weighted Citation Percentile. The team supervised 2.5-fold more PhD students and doubled the doctoral degree awards that were supported with full and matched-funded scholarships with partner organisations. SESRC researchers won esteemed advisory positions and prizes and contributed to the economy and society via partnerships with more than 20 business and non-profit organisations.</p> <p>b. Unit Structure and Research Approach</p> <p>SESRC is hosted within the Division of Human Sciences (DHS) of the School of Applied Sciences at LSBU. DHS has a tradition for delivering research-informed teaching and on the REF census date (31-July-2021) comprised 19 (17.6FTE) academic staff, of whom 15 (13.6FTE; 77%) are independent researchers with significant responsibility for research. Of them, 12 (10.6FTE) conduct research within the UoA24 domain descriptor and all (100%) are core SESRC members who have been returned in this submission. These include <i>three Professors</i>: Karamanidis, Mileva, Raab; <i>three Associate Professors</i>: de Oliveira, Gaoua, Hunter; <i>four Senior Lecturers</i>: Borges, Epro, James, Seeley; and <i>two postdoctoral Research Fellows</i>: AminiAghdam, Zaidell. In the REF2021 period, five leading researchers (5FTE, 47%) from research-intensive international organisations (2-Germany, 1-Iran, 1-Portugal and 1-Qatar) joined the team. These appointments were strategic and allowed SESRC to enhance its international standing not only in areas of traditional strength [<i>neuromechanics</i> (James, Mileva, Seeley), <i>exercise physiology</i> (Hunter, Zaidell) and <i>sport psychology</i> (de Oliveira, Raab)] but also in areas of emerging significance, such as <i>musculoskeletal biomechanics</i> (AminiAghdam, Epro, Karamanidis) <i>environmental psychophysiology</i> (Gaoua) and <i>sports coaching</i> (Borges)].</p> <p>Five field experts were appointed as Visiting Scholars to augment our expertise with complementary skills and disciplines. These are: <i>in musculoskeletal and clinical biomechanics</i> Dr Cook (Head Coach, Norwegian taekwondo team) and Professor Solan (Consultant Trauma</p>

and Orthopaedics surgeon at Royal Surrey County Hospital and the London Foot and Ankle Centre); *in environmental sport psychophysiology* Professor Racinais (Head of Research in Aspetar, Qatar) and Associate Professor Girard (University of Western Australia); and *in sport coaching and performance* Dr Cooke (Senior Leader for High Performance Sport, Western Australia Institute of Sport).

Since REF2014, SESRC research has been consolidated around two multidisciplinary themes, which are distinctive in their methodological approaches but are united by SESRC's mission to conduct excellent and impactful research in sport performance, physical activity and health:

Mind and Motion (Raab leader). The research conducted under this theme focuses on the reciprocal interactions between perception, action and cognition and their implications in sport and exercise settings. In collaboration with national and international partners, our experts in *embodied cognition* (Raab), *perception-action* (de Oliveira), *cognitive psychology* (Gaoua), *coaching* (Borges), *elite athletic performance* (Epro), *exercise physiology and metabolism* (Zaidell), *strength and conditioning* (Hunter) and *motor control* (Mileva) apply behavioural and psychophysiological methods to investigate the role of environment in the development and maintenance of expert decision making and healthy-lifestyle behaviours. The most prominent theoretical, methodological and empirical innovations that have emerged from the research programmes run during the REF2021 cycle align within three major dimensions:

- Understanding mechanisms of human behaviour from an embodied cognition perspective.
- Exploring person-environment interactions from an ecological rationality perspective.
- Examining human behaviour and performance from a psychophysiological perspective.

The integration of perspectives from core disciplines like psychology, physiology and neuroscience enables our projects to advance fundamental knowledge across theoretical borders and formulate research perspectives and recommendations for sport practice and physical activity promotion, as evidenced in our REF2021 Impact Case Study '*This Girl Can Lambeth*' (section 1e).

Body and Movement (Karamanidis leader). Under this theme, we conduct research that aims to improve understanding of the plasticity of the neuro-musculoskeletal system due to physical activity, injury, ageing and pathology. This is achieved by integration of general expertise in Sport and Exercise Sciences with specialisms in *gait biomechanics and trunk posture* (AminiAghdam), *muscle-tendon neuromechanics* (Epro, James, Karamanidis), *cortical* (Seeley), *sensorimotor* (Mileva) and *visuomotor* (de Oliveira) *control of movement*. In a collaborative environment, the team combines knowledge and experimental techniques from biomechanics, motor control, physiology and neuroscience to study the complex interactions between the constantly adapting neural and musculoskeletal systems along three dimensions:

- Exploring skeletal and muscle-tendon mechanosensitivity from the perspective of physiological, structural and morphological changes across adulthood.
- Understanding the dynamics of neuromuscular and mechanical interplay that govern effective and stable human movement.
- Investigating the aetiology, prevention and rehabilitation of musculoskeletal injuries in the fields of sport and physical activity.

The projects completed and the outputs published with this approach have brought international recognition to the team for its insights into the mechanisms underlying the plasticity of human movement control and regulation in healthy and pathological conditions. Based on this knowledge the team has developed strategies for improved performance and health across the adult lifespan and generated practical recommendations for sports, clinical settings, communities and the ageing individual. Our REF2021 Impact Case Study '*Temulab*' illustrates how the

research under this theme has driven technological innovation for enhanced sport performance (section 1e).

c. Research Strategy and Achievements

In its REF2014 submission, the SESRC set the following strategic aims for the succeeding five-year period: i) grow the volume and vitality of the team; ii) strengthen our scientific reputation, research power and international footprint; iii) enrich our research infrastructure through increased income, partnerships and facilities; iv) enhance the impact from our fundamental and applied research. To achieve these aims, the 2015-2020 *SESRC Research Strategy* focused on:

AIM 1. Enhancing the team's research excellence to facilitate strategic scientific and industrial collaborations and partnerships. In the REF2021 cycle, the team has grown by 13% compared to REF2014 (10.6 FTE vs 9.4 FTE) and achieved five (47% FTE) strategic appointments and seven (66% FTE) staff promotions. The team has implemented a new publication strategy informed by annual internal and external evaluations conducted by 11 external field-experts (four from UK and seven from leading EU universities). Consequently, the quality of our research outputs has significantly increased. The team has published 155 peer-reviewed research outputs (118 original research; 37 editorial, review and perspective articles, books and book chapters; an average of 14 outputs/FTE), 36% of which rank within the top 25% Field-Weighted Citation Percentile (7% in the top 10 percentile) and 32% attained an above the field-average Field-Weighted Citation Impact (FWCI>1) with a peak of FWCI=7.5.

82% of SESRC outputs apply multidisciplinary methodologies and 91% are co-authored with scientists from 90 UK, EU and worldwide partner universities and organisations (on average by five co-authors, 77% co-authored with researchers from outside of the UK). Through dedicated support for exchanged visits (*Table 1.11-12*), co-production of research outputs, joint funding bids, PhD co-supervision and seminars, SESRC has achieved recognition as a favoured partner for research expertise, innovation and policy consultancy. This is evidenced by SESRC members being: elected to national and international advisory and management boards of scientific and professional institutions and government agencies; awarded honorary positions; and invited to chair sessions, deliver keynotes and organise international scientific forums (*Table 1.1-3*). These achievements have allowed the team to contribute to new trends in research and to inform new sport and physical activity practices, policies, and programmes.

AIM 2. Securing funding support for interdisciplinary fundamental research with high translational potential to advance knowledge and underpin innovative solutions and recommendations to healthcare and sports performance problems. Since 2016 and in recognition of its high performance, SESRC has earned considerable autonomy within LSBU to manage its own income streams and invest the annual budget according to strategic priorities. By following a mixed strategy of undertaking both high and medium risk bidding opportunities combined with doctoral research fully or matched-funded with external partner-organisations, the team has earned £1,835,251 of research funding (20% increase compared to REF2014) to invest within our research environment (*section 3a*). Both SESRC Research Fellows (one per research theme) are also fully or co-funded by external partners (AminiAghdam – OrthoSportLab GmbH; Zaidell - Sport England).

AIM 3. Investing in world-class facilities and research techniques. Since 2014, SESRC has invested £808,701 to modernise and augment the research infrastructure available to the team for research, innovation and teaching. With dedicated grants for research capital from external partners (£300,000) and LSBU QR funding (£304,313), SESRC established two brand new laboratories equipped for advanced research in *Neuromechanics of Human Movement and Environmental Psychophysiology*. Income from the *London Agri-Food Innovation Clinic* project (LAFIC, see *section 3a*) and a HEFCE Catalyst grant (£204,388) supported the modernisation of the extant (*Gait analysis, Elite Human Performance, Exercise Physiology and Nutrition and Neuromechanics*) laboratories with state-of-the art technology (*section 3b*).

AIM 4. Increasing the vitality and sustainability of our research by increasing the number of doctoral, postdoctoral and visiting researchers. In the REF2021 cycle, the team supervised 2.5 times more PhD students (25 vs 10) and achieved 1.9 times more completions (10 vs 5.2) compared to REF2014. In addition to the 25 students registered at LSBU (2.4/FTE; 11 International and 14 UK), the team co-supervised further eight PhD students (six awards) based at partner-universities (*Table 1.8*). Since 2014, SESRC also hosted 10 international scholars from the UK, EU, Saudi Arabia, Brazil and Russia for postdoctoral training and professional career development. In 2017, SESRC won support from the UK Fulbright Commission and the US Department of State to host a Fulbright Specialist from Long Island University in New York. This project yielded a lasting research partnership and facilitated the international translation of our '*This Girl Can Lambeth*' project design in the USA.

SESRC attained an increased capacity and competency for doctoral supervision via staff-development and mentoring initiatives, supported by LSBU's *Researcher Development Concordat* and the Visiting Scholars as external PhD supervisors and staff mentors. As a result:

- 45% of the 155 research outputs published by SESRC in the REF2021 period have resulted from doctoral research and were co-authored with PhD students.
- Our PhD students won 13 prestigious national and international awards for best research and innovation (*Table 1.4*).
- All 10 PhD students who graduated since 2014 have progressed in the year of their completion into competitive postdoctoral, professional and academic positions at LSBU (Epro), national (e.g., University of East London, British College of Osteopathic Medicine, Guy's and St. Thomas's NHS Foundation Trust, Astellas Pharma, Fortius Clinic) and international (e.g., Frontiers Media, SmartStep Consulting GmbH) organisations.

d. Facilitating and Supporting Interdisciplinary Research

Our philosophy. SESRC's thematic and project-specific, rather than disciplinary and group-based approach to research follows a 27-year tradition of facilitating and supporting interdisciplinarity, multidisciplinary and transdisciplinarity. We define interdisciplinarity as an approach that goes beyond multidisciplinary by seeking to analyse, synthesize and harmonise links between research disciplines into a coordinated and coherent whole. We apply transdisciplinary approaches to project design to move beyond the traditional boundaries between natural, social and health sciences. This philosophy has enabled us to create a vibrant research environment, underpinned by a culture of integrity and support between members with expertise spanning the core disciplines of Sport and Exercise Sciences and operating in multidisciplinary labs and interdisciplinary PhD offices to run transdisciplinary fundamental and applied projects. This environment has facilitated SESRC's ability to generate insights that respond to the needs of the sport and public health domains and transform the lives of individuals, communities and businesses.

Our achievements. To fulfil its philosophy, SESRC has fostered strategic relationships with, and worked alongside, researchers from other universities and disciplines as well as public and professional stakeholders. We have achieved:

- **Increase of international research collaborations** with world-leading scientists and teams, which facilitated the production of excellent interdisciplinary research outputs and doctoral projects, impactful funding proposals, joint seminars and colloquia, and staff and PhD exchange visits (*Table 1.11-12*). Raab and de Oliveira are part of a large-scale consortium of universities set to improve understanding of multi-task integration in implicit motor learning and performance, and the psychophysiological correlates of core executive functions. Karamanidis, Epro and Seeley work with leading teams from Humboldt University Berlin, Liverpool John Moores University and Koblenz University among others, in the fields of muscle-tendon unit adaptations with ageing and during rehabilitation from sport related injuries, as well as dynamic postural stability training for fall prevention. AminiAghdam and Karamanidis collaborated with the Friedrich Schiller

University in Jena to study the role of trunk orientation on the kinetic patterns during locomotion on uneven ground and gait perturbation. Mileva explored the neuromechanical and metabolic determinants of fatigue during exercise and immobilisation (with University of Exeter) and in response to different training loads in elite cyclists (with British Cycling) and varying levels of gravitational unloading (with King's College London, the Institute of Movement and Neurosciences at the German Sport University and the European Astronaut Centre in Cologne). With partners from the University of Western Australia, Murdoch University and The Altitude Centre, Gaoua and Hunter gained insights into the benefits of hypoxic training in exercise programmes for overweight-to-obese individuals. Joint projects with clinical experts identified biomechanical gait parameters that inform rehabilitation practice for stroke survivors (James with King's College London and Guy's and St Thomas's Hospital London) and optimised the use of neuromuscular electrical stimulation as an adjunct therapy for hallux valgus deformity (James, Mileva and Karamanidis with Royal Surrey County Hospital).

- **Expansion of methodological capacity** of our on-campus laboratories by winning grants for use of national facilities (£17,700; Diamond Light Source, Ltd; Science & Technology Facilities Council) and gaining access to exclusive research facilities and expertise based at partner-organisations. These include: fMRI at the University of Exeter; Indoor Olympic cycling track at the British National Cycling Centre in Manchester; Environmental chambers in FIFA's Medical Centre of Excellence Aspetar in Qatar; Vertical treadmill in the Institute of Aerospace medicine in Germany; Motion Analysis systems at the Institute of Biomechanics and Orthopaedics at the German Sport University.
- **Integration of SESRC scientific expertise with practical perspectives** from elite sport and clinical environments by engaging Visiting Scholars (*section 1b*) as external doctoral co-supervisors. In the REF2021 period, these interdisciplinary teams co-supervised six PhD projects (two completions), co-authored 12 peer-reviewed publications, and attracted £110,000 in funding from sport and health business and non-profit organisations in the UK (The Altitude Centre, British School of Osteopathy, Guy's and St. Thomas's NHS Foundation Trust, English Institute of Sport, and British Orthopaedic Foot and Ankle Society) and the EU (BodyCap Ltd, France).
- **Implementation of a research co-production approach** by engaging with external stakeholders in the design and the delivery of our projects. This approach has facilitated direct translation of SESRC fundamental research into: i) new product design and development; ii) methodological innovation; and iii) recommendations for improved practice of policy makers, local governments and sport and health practitioners (*section 1e*). In July 2020, a partnership of five LSBU research centres, including SESRC, won approximately £1,500,000 award from NIHR to form one of the four national *Public Health Intervention Responsive Studies Teams (PHIRST-London)*, which is tasked with evaluating local government schemes aiming to influence public health and health inequalities. This is an outstanding example of success in fostering interdisciplinarity and building research and civic partnerships.

e. Impact Strategy

SESRC's vision for contributing to the economy and society is realised by working closely with external stakeholders. Our targeted beneficiaries are local communities, athletes and sports practitioners, clinicians, the health and sports services and industry, and policy makers. We offer them high research standards and high-level expertise, and we support them with internationalisation, an understanding of benefactors' needs, and public engagement and dissemination. Our research engages vulnerable, marginalised, excluded or hard-to-reach groups to investigate the barriers to sustainable engagement in sport and exercise and inform communal sport and fitness programmes. Research involving elite and recreational athletes informs the development of biotechnologies that improve the practice of sports and physical activity and lead to optimised sport performance and quality of life.

Key to SESRC's **Impact strategy** are: i) building national and international strategic relationships, partnerships and collaborations; ii) staff competence development and mentoring; iii) planning for and monitoring the impact component in funding applications; and iv) stakeholder engagement. Since 2008, the establishment of SESRC's *Human Performance Centre* has facilitated impact by identifying, from the team's research, the activities and ideas with impact potential and providing effective pathways for their development. Our major **pathways to impact** are:

- *Engagement* of SESRC members as scientific advisors to regulatory agencies, health and sports organisations and public bodies (*Table 1.1*).
- *Implementation* of research-informed diagnostic technology and software assisting training programmes for athletes and clinical decisions for prevention and rehabilitation from injury.
- *Facilitation* of practitioners' use of research outcomes in conducting their work.
- *Influencing* adoption of research evidence in the practice of local government, NHS Clinical Commissioning Groups, sports/leisure providers and education institutes.
- *Raising* awareness of the individual and community benefits from engaging in sport, and following healthy and active lifestyles (*Table 1.10*).

Key to realising impact from these pathways is SESRC's engagement with stakeholders for designing practice-informed research projects that allow the simultaneous advancement of knowledge and achievement of impact. Our REF2021 Impact Case Studies, presenting the '*This Girl Can Lambeth*' and '*Temulab*' projects, are significant testimonials for the mutual benefits from this approach. Combined, these projects have attracted £556,000 investment into SESRC research.

The first project (Mileva, de Oliveira and Zaidell) formulated recommendations for effective strategies to engage young women in sport and physical activity that have: i) informed Lambeth Council's approach for future service commissioning and sport and leisure provision; ii) influenced Sports England's 10-year community sports vision, *Uniting Movement*; and iii) were internationally translated. The findings from the research projects conducted by de Oliveira, Mileva and Zaidell in collaboration with Lambeth and Southwark Councils and local charities (*Table 1.9*) were referenced in the recommendations on how to get the nation moving through sport and physical activity, submitted by the British Association of Sport and Exercise Sciences in December 2020 to the House of Commons' *Digital, Culture, Media and Sport Select Committee*. In 2017, Borges, Gaoua and Mileva set a partnership with member-organisations from the UK Sport for Development Network to explore how sport-based activities can facilitate community development and prevent young people's involvement in antisocial behaviours. The research findings were outlined in a response to the recent call from *the House of Lords' Committee on a National Plan for Sport and Recreation* for evidence on "How can we lead more active lifestyles?"

The second project, led by Karamanidis and Epro, realised impact on coaching practice for preparation of elite athletes for major competitions by the developed and patented mobile device *Temulab*[®]. The device instantaneously diagnoses athletes' susceptibility to Achilles tendon overuse injury. It has also been adopted in private medical practice (Lanserhof at the Arts Club London) to enhance interventions that involve therapeutic exercises for knee osteoarthritis, Achilles tendinopathy, Anterior Cruciate Ligament rupture and fall prevention. Lanserhof has also implemented use of software developed by the SESRC team in their practice, in collaboration with OrthoSport GmbH, for automated analysis and enhancement of muscle-tendon structure and function in recreational athletes. The cooperation with the company Protendon GmbH & Co.KG led to the development of several other products including *Temustrain* and *Temuplate*. The German Olympic Athletic Training Centres in Rhineland and Hessen are using these devices to analyse muscle-tendon structure and function in elite track-and-field athletes. The knowledge accumulated via these partnerships has opened pathways for further clinical applications of these devices; for example, to study mechanically- and virtually- induced perturbations to gait in order to test and improve fall-resisting skills in the healthy and in

pathological conditions (collaboration between Karamanidis and German Social Accident Insurance).

f. Research Governance

SESRC is managed by a team led by Mileva since 2013. It develops SESRC research and impact strategies and monitors their delivery. The Theme Leaders (Raab and Karamanidis) oversee the implementation of the research strategy and facilitate interdisciplinary research activities. The Impact Leader (James) interacts with the Theme Leads to facilitate and monitor the implementation of SESRC Impact strategy. All members fulfil task-management roles to monitor progress with grant proposals and delivery, publications, partnership and infrastructure developments, esteem and dissemination activities. The executive team works closely with the School of Applied Sciences' Director of Research and Enterprise and LSBU's Central Research, Enterprise and Innovation Department. In the annual SESRC review and half-yearly 360°-monitoring meetings, the SESRC members reflect on achievements and research priorities. Monthly PhD and staff research presentations, interdisciplinary seminars and invited-guest talks facilitate development of a collaborative culture via task- and person-oriented research management. All senior researchers contribute to the School's mentoring program (section 2a).

g. Research Strategy 2021-2026

From 2021 onwards, SESRC is modernising its research structures in response to the enhanced research capability of its members, the improved facilities and the expanded and strengthened network of stakeholders and international collaborators. Three new and distinctive research themes have emerged: i) *Performance and Exercise Psychology*; ii) *Musculoskeletal Biomechanics*; and iii) *Environmental Physiology*. The shift to more specialist themes will further strengthen SESRC's research output quality and the focussed recognition of SESRC's expertise by the wider research and professional community. Specific topics (e.g., fatigue, sports performance, ageing) will facilitate collaboration between and beyond the three themes and, in addition, will enhance the *Human Performance Centre's* ability to attract stakeholders, develop sustainable projects and meet client needs. Our focus for 2021-2026 will be to consolidate the three interdisciplinary research themes through an optimised governance structure and infrastructure that delivers world-leading research, societal impact and innovation.

Our **strategic aims** for 2021-2026 are to:

- *Enhance* the rigour, significance and impact of our research **outputs** by employing advanced fundamental and applied approaches to investigate and address real-world challenges in the areas of sport performance, physical activity, ageing and health.
- *Enrich* our **research environment** by increasing the vitality of our postgraduate and postdoctoral research, and supporting the research career development of staff.
- *Increase* the translational **impact** of our research by developing new and existing partnerships for consultancy and innovation to improve sport performance, medical practice and health in our communities via our *Human Performance Centre*.

To achieve these aims, SESRC will nurture a more equitable, supportive and inclusive environment. Hence, we are committed to achieving the following **activity targets**:

- *Enhance our research productivity* through mechanisms such as staff development and sabbaticals, funding support for early career researchers and recruitment of high-quality staff from all career stages based on research fit, record of accomplishment and potential.
- *Increase our scientific influence and recognition* through publishing at least two outputs per FTE per year of international significance in collaboration with leading scientific partners as well as by organising annual joint research symposia and exchange training programmes.
- *Attract higher income* (at least 30% per FTE) from key funding bodies, research contracts and grants for doctoral scholarships and postdoctoral fellowships, with a specific focus on the *Big Science* research agendas related to physical activity, health and ageing.

- *Focus on recruitment* of high-quality postgraduate research students by developing new, internationally competitive PhD research projects with high-profile partners and world-leading research departments (two new studentships per year).
- *Strengthen and expand* our collaborations with key local and international stakeholders in our research by instigating joint projects and funding bids, translation into practice and dissemination of our research insights.
- *Align the activities* of the *Human Performance Centre* with the three new research themes to ensure that our research results in clinical and sports application.

2. People

a. Staffing Strategy and Staff Development

At the REF2021 census date, SESRC comprised 12 academic staff members (10.6FTE), with 100% eligible staff returned in this submission. Of them, four were returned to REF2014 (de Oliveira, James, Mileva, Raab). During the REF2021 period, seven staff left LSBU to take on more senior positions in other academic and business organisations. This has allowed the unit to make strategic enhancement of expertise that aligns better with the priority research themes. The SESRC staffing strategy employed the following mechanisms to enhance research capacity and support academics in realising their potential:

- *Recruitment of experts* from international research-intensive organisations at various stages of their career with competences aligning to, or strengthening, our interdisciplinary research themes (section 1b).
- *Career development support* to SESRC members wishing to enhance their research portfolio and gain promotion. The SESRC provides members with career mentoring and assistance to engage in collaborations; covers open access publication fees and facilitates opportunities to win seed-corn funding for small pilot projects; reduces teaching and administrative loads; and arranges access to unique equipment. All newly recruited staff and those returning after prolonged leave receive seed-corn funding as well as mentoring support by an experienced SESRC member. This includes, but is not limited to: discussions around career development; familiarisation with the research environment and processes at LSBU; and joint development and reviewing of grant applications and research publications.
- *Promotion of a thriving and inclusive research culture* via mentoring to facilitate independence in research by writing research papers, developing funding applications, gaining supervisory experience and/or a doctoral degree. Since 2014, two academics from DHS with expertise in sport and exercise science but without Significant Responsibility for Research (SRR) in their workload (Hunter, Seeley) and one early career researcher (Zaidell) met the LSBU SRR criteria and became core SESRC members. Three further academics have enrolled on part-time PhD studies at SESRC.

To develop their research management skills, SESRC members have access to centrally organised training and gain hands-on experience by involvement in PhD supervisory teams led by a more experienced member. SESRC also facilitates staff engagement in networking by funding presentations at scientific events, exchange visits for training, setting up collaborative projects and development of joint publications. SESRC offers mentoring to PhD students seeking postdoctoral positions after completion. Since 2014, career development of SESRC members was supported with £741,202 funding from LSBU QR and members' external income. Overall disbursement was £354,854 as PhD fee-waivers and matched-funding, £304,313 for research equipment, £62,035 seed-corn funding and £20,000 for open access publications. This strategy has resulted in the promotion of eight SESRC members (67%) across all career stages: Mileva to Professor A; Karamanidis to Professor B; de Oliveira, Hunter and Gaoua to Associate Professor; Borges, Epro and James to Senior Lecturer.

b. Research Students

In 2013/14 SESRC had 4 students (2.5FTE) studying for a doctoral degree, which increased by 4-fold to 16 (14FTE) students (12 studying on full-time and 4 on a part-time basis) in 2019/2020. In the REF2021 cycle, overall 25 PhD students were enrolled (2.4 per staff FTE) and 10 doctoral completions achieved. Compared to REF2014, this represents a 2.5-fold increase for registered PhD projects and 60% more completions. SESRC trained 11 overseas (7-EU; 1-USA; 3-Asia) and 14 UK PhD students, which created a thriving multicultural postgraduate research community of students studying on either a full-time (16) or part-time (9) basis. Of the trained PhD students, 48% gained scholarships matched-funded by external partners (*section 3a*), 32% won full scholarships from SESRC and the School of Applied Sciences, and 20% were self-funded. Since 2016, our PhD students won 13 prestigious awards for best research and innovation at national and international events (*Table 1.4*). These achievements establish that the SESRC has successfully created a research environment that fulfilled its strategy for growing the size of our PhD community and the team's international reputation for excellent postgraduate education.

To attract the best candidates, in addition to the standard approach for student recruitment on a competitive basis, we advertise and promote open PhD positions at SESRC by staff presentations at our partner universities worldwide. This approach and the provision of PhD scholarships has attracted strong international PhD students. Dedicated multidisciplinary teams of minimum two staff members from each research theme supervise each student to stimulate an interdisciplinary approach and incorporate both mechanistic and applied aspects of the investigated topics. Consultants from the external partner-organisations also actively contribute to project supervision, student training and dissemination activities, which has increased their competencies and employment prospects.

The School of Applied Sciences has a dedicated Director for Postgraduate Research (Karamanidis since 2019), who works closely with the elected student representative. Karamanidis, Mileva and the student representative are members of the *Research Board of Study*, which manages postgraduate training at LSBU. SESRC supports, from its own QR budget, the additional needs of all students for research expenses, project-specific training, networking and small-scale equipment. Our postgraduate students occupy two fully-equipped open-space offices and share two common rooms with staff and other PhD students, facilitating informal meetings and research discussions.

To enhance their scientific competencies and communication skills our PhD students present their work at the bi-monthly SESRC research seminars, the bi-annual School postgraduate mini-conference, the annual LSBU postgraduate conference organised by LSBU's *London Doctoral Academy* and the PhD colloquium (webinar) co-organised with Humboldt University in Berlin. They also receive annual travel grants to present at national and international scientific conferences. Strategically, our supervisors engage PhD students in writing research bids and submitting research manuscripts to high-quality peer-reviewed journals. Our PhD students are co-authors on 45% of SESRC's 155 outputs in the REF2021 period and have won awards as lead authors of research papers, young investigators and three international prizes for best thesis (*Table 1.4*). The students are also encouraged and supported by staff to teach on our undergraduate courses, engage in knowledge transfer and gain work experience via our collaborations with the sports and health industries, clinical and community settings, and elite sport organisations. They have visited and run studies alongside experts at the Olympic Training Centre Rhineland, German Social Accident Insurance, the FIFA Medical Centre of Excellence in Qatar, the national centres of British Swimming in Loughborough and British Cycling in Manchester, and the medical centre of Lanserhof at the Arts Club, London (among others).

c. Equality, Diversity and Inclusion

Since its establishment, SESRC has been fully committed to excellence in research and research training by creating an environment that fosters equality, diversity and inclusivity of all

members. SESRC membership consists of 12 (10.6FTE) independent researchers (67% men, 33% women) and a balance across career levels - three senior, five mid-career and four early-career researchers. Staff is aged between 30 and 70 years (mean 45) and holds membership over 2 to 25 years (mean 9.5). Currently, 17% of SESRC members identify themselves of mixed ethnicity, 8% – BAME, 50% – white/non-British and 25% – white/British ethnic origin. Of our 25 PhD students: 12 are female (48%) and 13 (52%) male (52%); 19% are of BAME, 7% of mixed, 37% of white/non-British and 37% of white/British ethnic origin.

We respect the impact of personal and professional factors on individual experiences. This philosophy has promoted staff affinity for projects requiring elevated levels of social engagement and understanding of multicultural dynamics. LSBU *EDI Policy* and *The Concordat for Researcher Development* are fully integrated in our strategy and processes for supporting, monitoring and developing members' careers at any stage. Mileva is the School's representative to LSBU's *Researcher Development Group*, established in 2014 to oversee actions and promote good practice, for which LSBU gained four *EU HR Excellence in Research Awards* (2014, 2016, 2018, and 2020). Staff and PhD research projects are ethically scrutinised by the School's *Research Ethics Committee*, chaired since 2019 by de Oliveira, who is also a member of the *University Research Ethics Panel*. All members receive training on research ethics and review ethics applications. All members have been informed of the principles that define staff return to REF2021 assessment and the output evaluation and selection approach set out in the LSBU *REF2021 Code of Practice*. The *Equality Impact Assessment* of SESRC outputs submitted to REF2021 has confirmed that the output attribution to individual members is not biased and that the distribution of selected outputs among staff broadly reflects their characteristics.

3. Income, infrastructure and facilities

a. Income

The income earned by SESRC in the REF2021 period totals **£1,835,251** (£173,137 per FTE; £262,179 average annual income), which represents a 20% increase compared to REF2014 and has been invested in expanding our research capacity by strategic appointments, new and modernised facilities and methodological base. SESRC implemented a strategic approach to diversify the income streams with consideration of the changing external funding environment for Sport and Exercise Sciences. SESRC income comprises: i) competitive external grants, research contracts and in-kind income (**£909,661**, a **50%** increase compared to REF2014); ii) **£508,701** investment in research capital from HEFCE Catalyst and LSBU QR funds; iii) internal QR funding for seed-corn grants (**£62,035**); and iv) PhD scholarships (**£354,854**).

In the REF2021 period, SESRC made a significant investment (£354,854) into full or match-funded scholarships additionally supported with £197,000 by external partner organisations. Funding partners include the sports and health industries, governmental and charitable organisations from the UK (e.g., Sport England, Lambeth Council, British School of Osteopathy, Guy's and St Thomas' Trust; Active Community Networks, The Altitude Centre, OrthoSportLab) and EU (e.g., Body Cap Ltd, France; German Social Accident Insurance). Beginning 2019, German Social Accident Insurance has committed £450,000 over six years for research and consultancy into falls and occupational safety supported via four bespoke PhD scholarships.

SESRC won £372,733 funding support from UK and EU health and sport businesses and non-profit organisations to conduct a series of contracted research projects. These include: development of a new method and prototype orthotic for strengthening the foot musculature (James and Mileva; British Orthopaedic Foot and Ankle Society), collaborative study of the impact of coach migration on their performance with the Football Federation in Portugal (Borges, UEFA), studies of the benefits from therapies using various physical modalities (e.g., electrical muscle and brain stimulation - Mileva and James, whole-body and local vibration - Zaidell, cooling strategies and hypoxic exposure - Hunter and Gaoua, and micronutrient intake for faster recovery from intensive exercise, preventing sarcopenia, and improving performance and body composition – Mileva).

In 2018, LSBU won two six-year research and enterprise projects, co-funded by the European Regional Development Fund (ERDF). The *London Agri-Food Innovation Clinic* project (LAFIC, £2,000,000) supports and promotes research and innovation in London's food businesses, and the *Simulation for Digital Health* project (SimDH, £3,000,000) health technology start-ups and SMEs in innovation, development and delivery of new products and services. SESRC engagement in the design and delivery of these two projects has so far brought in £126,000 of research income.

Between 2016 and 2019, de Oliveira, Mileva and Zaidell completed a multi-partner project funded by a £636,215 grant from Sport England and Lambeth Council to support the design, delivery and evaluation of a large-scale community-based intervention programme. The project '*This Girl Can Lambeth*' engaged 5,329 young women (14-25 years old, >50% BAME, 10% with disability) and produced rich research data about the benefits, facilitators and barriers to young women's participation in sport and the cost-effectiveness of service commissioning and delivery.

In 2018, Karamanidis won three research contracts with a cumulative value of £598,000. Over three years these contracts invested in: i) SESRC facility development, match-funded PhDs and a fellowship position for research into sport injury diagnostics and prevention (Lanserhof at the Arts Club, London); ii) development of fall-resisting skills via mechanically- and virtually-induced gait perturbations (Koblenz University of Applied Sciences, Germany); and iii) assessment of muscle-tendon units for prevention of tendon injuries (OrthoSportLab GmbH).

b. Infrastructure and Facilities

Traditionally, SESRC research and innovation activities took place in research laboratories, specialising in the main disciplines within sport and exercise science. Since 2014, and in line with our strategy for building research with a multidisciplinary thematic focus, SESRC has fully reorganised its research and methodological base. A dedicated sport science technician manages our lab infrastructure with support from Central Technical Services who offer workshop use and a variety of expertise for manufacturing bespoke research devices.

Two new laboratories with state-of-the art equipment were established to facilitate research under our two research themes. The *Neuromechanics of Human Movement* lab is dedicated to studying human locomotion, balance, gait perturbations and neuromechanical properties of muscle-tendon units. It is equipped with a motion capture system with 16 infrared cameras (Qualisys), ten muscle-tendon training devices TEMUTRAIN, four 16-channel analogue-to-digital converters, three force plates (Kistler), two sets of augmented and virtual reality glasses, two custom-made pneumatic-driven gait perturbation devices, two mobile ultrasound devices (ESAOTE MyLab Gamma) and singles of a Lode Sport 2XL treadmill, state-of-the-art overground safety harness rail, HUMAC isokinetic dynamometer, tendon-muscle analysis device TEMULAB, custom-made mobile force plate for assessing posture and balance, peripheral nerve stimulation device (Digitimer) and a multichannel EMG system. The *Environmental Psychophysiology* lab is set up for studies of human interactions with the physical environment using various equipment: mobile hypoxicators, a hypoxic chamber, Doppler ultrasound, laser-Doppler flowmetry and imaging, near-infrared spectroscopy systems (Hamamatsu and Moxy), and a suit for cardiorespiratory and metabolic measurement. A new environmental chamber has a cardiopulmonary system (Cortex), eye tracking and mobile EEG (Emotiv) systems, virtual and augmented reality glasses, prism goggles, an iCool icebath, and software for assessing emotional health and cognitive function (Cantab).

With investment from research capital, the facilities in the other four laboratories (*Gait analysis, Elite Human Performance, Exercise Physiology and Nutrition, Neuromechanics*) were improved via acquisition of new systems for laboratory and field studies. Examples include: a 24-camera clinical gait analysis system (Vicon), five force platforms (Kistler), four Watt bikes, two isokinetic dynamometers, two medical scales for body composition analysis (Tanita) and singles of a two-metre plantar pressure mapping system, transcranial direct current stimulating device

(Neurostim), transcranial magnetic (Magstim) and peripheral nerve stimulation (Digitimer) systems, high-density EMG system (Quattrocento, OT Bioelettronica), Wahoo Smart Trainer and NordBord hamstring testing system, The University encourages internal partnerships and shared use of facilities with other LSBU research teams (e.g., Engineering - UoA12). Through collaborative arrangements with external research partners SESRC also has access to off-site facilities (*section 1d*). This approach enabled SESRC members to incorporate advanced methodological approaches into excellent research outputs published in high-impact journals, complete prize-winning PhD projects and attract funding and partnerships with esteemed teams across the world

4. Collaboration and contribution to the research base, economy and society

a. Our Approach to Research Partnerships

SESRC has successfully maintained and expanded its external collaborations to support excellent research for advancements in science, economy and professional practice. SESRC strategically invested in exchange research visits, joint publications, research bids and PhD project supervision, which allowed for combination of competence, expertise and research infrastructure for the benefit of larger multidisciplinary projects (*section 1c*). Our philosophy for conducting interdisciplinary thematic research (*section 1d*) as well as our effective Impact and dissemination strategy (*section 1e*) resulted in enhanced visibility of the SESRC and scientific and social recognition for expertise and influence (*Table 1*). SESRC established a global network of academic and professional partnerships with scientists from more than 100 UK, EU and worldwide partner-universities and research organisations. The vitality and sustainability of our approach is evidenced across the whole spectrum of SESRC research activities.

b. Our Approach to Stakeholder Engagement and Impact

In the REF2021 cycle, SESRC has strengthened its traditional reputation for problem solving, socially- and commercially-focused approaches to research, underpinning our contribution to economy and society. To respond to national priorities and global challenges we sustained our previous links and built more than 20 new productive collaborations with commercial and governing organisations, local authorities and charities related to sport, physical activity and health (*Table 1.9*). Our co-production approach to development of funding bids (*section 1d*) created contemporary topics for research, PhD projects, training and learning opportunities and joint events and seminars for engagement with key research users and beneficiaries (*Table 1.10*). *Section 1e* provides examples of the impacts of SESRC research.

To enable contribution to science, economy and the society, SESRC fully complies with LSBU's *Policy on Open Research Data*. In the REF2021 period, SESRC has invested circa £20,000 of our income to support the open access publication of 15 outputs and a further £30,000 in stakeholder engagement and the dissemination of research findings to scientific, professional and public audiences. This has stimulated dynamic knowledge exchange, public engagement and dissemination with/via national and international scientific and business partners (*Table 1*).

Table 1. Indicators of engagement with stakeholders and contributions to and recognition by the international scientific community

Category	SESRC member	Exemplars
1. Leadership and membership of scientific and advisory boards and committees	de Oliveira	General Secretary European Federation of Sport Psychology (FEPSAC)
	Gaoua	Expert Advisory Panel to the African Federation of Football, 2018
	Karamanidis	<i>Editorial boards:</i> 36 th (New Zealand, 2018), 37 th (USA, 2019) and 38 th (UK, 2020) International Conferences on Biomechanics in Sports; <i>Accreditation:</i> Undergraduate Programme of

		Physical Education and Sport Science, University of Thessaly, 2019
	Mileva	<i>Grant reviewer:</i> Biotechnology and Biological Sciences Research Council; The University of Rome "Foro Italico"; <i>Expert Advisory Board:</i> InnovaSpace - Space Without Borders; Valkyrie Industries Ltd. <i>Expert opinion:</i> Advertising Standards Agency and the Charity Commission, UK; Food and Drug Administration, USA; Therapeutic Goods Administration, Australia
	Karamanidis, Mileva	<i>External reviewers for senior academic promotions:</i> Liverpool John Moores University; University of Memphis; Koblenz University of Applied Sciences; Humboldt University Berlin; St Mary's University, Twickenham
	Raab	President of FEPSAC; Vice-speaker for the Sport Psychology section of the German Society of Psychology
2. Honorary appointments	Karamanidis	<i>Visiting Professorships:</i> Department of Exercise and Sport Science, LUNEX International University of Health, Exercise and Sports, Luxembourg; Institute of Sport Science, University of Vienna
	Mileva	<i>Honorary Academic Research Fellow:</i> Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter
	Raab	<i>Visiting Professorships:</i> Wingate, Israel; Melbourne, Australia; Hamilton, New Zealand
3. Invited keynotes and lectures, chairing and organising symposia	Epro	Estonian Athletics Association, Pärnu, 2018
	de Oliveira	Conference of the European Network for Young Specialists in Sport Psychology (ENYSSP), 2019
	Hunter, Mileva	Institute of Sport, Ural Federal University, Russia, 2014
	Karamanidis	<i>Organising Committee:</i> International Autumn Schools on Movement Science, Humboldt University Berlin, 2016, 2017; 20 th anniversary MOBEX, Stuttgart, 2017; Qualisys virtual undergraduate meeting, UK and Ireland, 2020; 23 rd (2018, Dublin) and 24 th (2019, Prague) Congresses of ECSS; ISPGR World Congress, Edinburgh, 2019
	Mileva	SIRACH network workshop at Rutherford Appleton Laboratory, 2017
Raab	<i>Organising Committee:</i> World Congress of Performance Science, Kyoto, 2016; International Congress of Applied Psychology, Montreal, 2018; European Society of Vision, Trieste, 2018; German Association of Sport Science, 2018 <i>Scientific committee:</i> European Sport Psychology Congress, Muenster, 2019 Congress president and program director of the sport psychology congress 'Psychophysiology of action' <i>Keynotes:</i> Sport Science conference, Germany, 2019; Turkey Sport Psychology Congress, 2020;	

		ENYSSP Congress for sport psychology, Belgium, 2020; Wingate Business Congress and Beer-Sheva Business School, Israel
4. Prizes	Epro (Karamanidis)	Runner-up in the 2017 Journal of Experimental Biology Outstanding Paper Prize; Best Student Poster Presentation, BASES Biomechanics Special Interest Group meeting, UK, 2017; Equal 5 th Young Investigator Award, 23 rd annual ECSS Congress, 2018; Winner Best Paper Award, 8 th World Congress of Biomechanics, German Society for Biomechanics, 2018; Most significant scientific research, Estonian Academy of Science, 2018
	Koenig (Karamanidis)	New Investigator 2 nd Poster Presentation Award, 35 th International Conference on Biomechanics in Sports, Cologne, 2017; 2 nd Best Student Oral Presentation Award, BASES Biomechanics Interest Group meeting, UK, 2017; Equal 5 th Young Investigator Award, 24 th annual ECSS Congress, 2019
	McCrum (Karamanidis)	Best Journal Paper Prize from the European Review of Aging and Physical Activity, 2017; 1 st PhD Thesis Prize, Dutch Society for Movement Sciences, 2019
	Attias (Mileva)	1 st PhD Project in Human Physiology Prize, German Aerospace Centre (DLR), Cologne, 2017
	Ottersen and Perez (James, Mileva)	Gold Rob Clarke Awards for Young Researchers, The Physiological Society, 2017 and 2018
5. Accreditation by professional Societies	de Oliveira, Hunter	BASES
	de Oliveira, Gaoua	British Psychological Society
6. Memberships of learned societies	de Oliveira, Raab	FEPSAC, German Psychology Association; German Sport Psychology Association
	Karamanidis	International, European, German and Hellenic Societies of Biomechanics; International Society of Posture and Gait Research; German-Austrian-Swiss Society for Orthopaedic Traumatology and Sports Medicine
	James, Mileva, Seeley, Zaidell	The Physiological Society
	All SESRC members	ECSS
7. Journal Editorships	de Oliveira, Gaoua, James, Mileva, Raab	Frontiers in Psychology
	James, Karamanidis, Mileva	Frontiers in Sports and Active Living
	Mileva	Human Sport Medicine Journal, Russia
	Raab	Psychology Sport and Exercise; Journal of Sport and Exercise Psychology; Sport Exercise and Performance Psychology; International Journal of Sport and Exercise Psychology
	Karamanidis	Applied Bionics and Biomechanics; European Review of Aging and Physical Activity; Frontiers in Physiology

		<i>Guest Editor</i> : Specialist research topic, <i>Frontiers in Physiology</i> , 2018
8. Formal PhD co-supervision at partner-universities	James, Mileva	King's College London
	Mileva	University of Exeter
	Karamanidis	Maastricht University
	Gaoua	Paris-8 University
	de Oliveira, Karamanidis, Raab	German Sport University; Augsburg University
9. Key industrial partners	Sport, health and wellness industry	Actegy Ltd; Brandhandling Ltd; Lanserhof at the Arts Club; The Altitude Centre; BodyCap Ltd; Horseware Ltd; McLaren Ltd; Mineks International; OrthoSport GmbH; Protendon GmbH & Co.KG; German Social Accident Insurance; FIFA Medical Centre of Excellence Aspetar, Qatar
	Charitable organisations	Active Communities Network; Silverfit; Fight4Change; Guy's and St. Thomas's NHS Foundation Trust; British Orthopaedic Foot and Ankle Society
	Sport governing bodies	British Cycling; British Swimming; Sport England; English Institute of Sport; FIFA Medical Centres of Excellence in Algeria, Qatar and UAE; Football Federation, Portugal; African Confederation of Football; German Olympic Athletic Training Centres in Rhineland and Hessen
	Local government	Lambeth and Southwark councils and NHS CCGs
10. Engagement with key research users and beneficiaries	All members	<i>Organisers</i> : 'Serious Sport' conferences at LSBU, 2013, 2014 and 2015
	Hunter, Mileva, Zaidell	"The truth about cosmetic treatments", BBC1, 2020
	Borges, Gaoua, Mileva, Zaidell,	<i>Scientific board</i> : 9 th annual conference of the UK Sport for Development Network: "Sport for Development – What are we developing?", LSBU, 2019
	de Oliveira, Mileva, Zaidell	<i>Organisers</i> : Panel-based debate "Can we break barriers in sport", co-funded by the UK Fulbright Commission, LSBU, 2018
	de Oliveira, Zaidell	<i>Organisers</i> : "This Girl Can Lambeth – what did we learn?" – webinar with public stakeholders, 2020
11. Invited research visits to key research partner universities	Karamanidis	Brunel University London (Dr Mohagheghi); Humboldt University Berlin (Prof Arampatzis); Manchester Metropolitan University (Prof Reeves); Liverpool John Moores University (Prof Maganaris); Koblenz University of Applied Sciences (Prof Hartmann); German Sport University Cologne (Prof Potthast)
	Gaoua, Hunter	Orthopaedic and Sports Medicine Hospital, ASPETAR, Qatar (Prof Racinais); China; Federal University of Pernambuco, Brazil
	Mileva	University of Exeter (Prof Bowtell); European Space Agency (Prof Rittweger); University of Oulu (Prof Tulppo); Ural Federal University, Russia

	Borges	Football Federation, Portugal
	de Oliveira	German Sport University
12. Invited research visits from partner-universities	Prof Harridge	King's College London
	Prof Maganaris, Dr O'Brien	Liverpool John Moores University
	Prof Arampatzis	Humboldt University Berlin
	Prof Hartmann	Koblenz University of Applied Sciences, Germany
	Dr Powell	University of Memphis, USA
	Dr Kunz, Dr Yildirim	OrthoSport GmbH, Germany
	Dr Ditroilo	University College Dublin, Republic of Ireland
	Prof Ellaway	Imperial College London
	Prof Wilson	University of Exeter
	Prof Maffioletti	Schulthess Clinic, Zurich, Switzerland
	Prof Millet	University of Lausanne, Switzerland
	Prof Barros	Federal University of Pernambuco, Brazil